Collaborative Quiz #4
Sol'ns
M. Ochi

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$\boxed{11}$ 1. $G(s)G_c(s) = \frac{K}{s+p} \cdot \frac{1}{s} = K \cdot \underbrace{\frac{1}{s(s+p)}}_{G(s)}$

2. 1 because of pole in $G(s)$ at the origin

3. $\Delta_{cl}(s) = s(s+p)+K$

$= s^2+ps+K$

asympt. stable for $p>0$, $K>0$ via Hurwitz criterion.

4. $s^2+2\zeta\omega_n s+\omega_n^2 = s^2+ps+K$

$2\zeta\omega_n = p$ $\qquad$ $\omega_n^2 = K$

$\omega_n = \sqrt{K}$

$\zeta = \frac{p}{2\omega_n}$

$= \frac{p}{2\sqrt{K}}$

$\boxed{12}$ 1. (b) b/c for a type 1 system, $e_{ss} = 0$ to a unit step.

2. $e_{ss} = \frac{1}{K_v}$, $K_v = \lim_{s \to 0} s K G(s)$

$$= \lim_{s \to 0} \cancel{s} \cdot K \cdot \frac{1}{\cancel{s}(s+p)}$$

$$= \frac{K}{p}$$

$\therefore e_{ss} = \frac{p}{K}$ $\Rightarrow$ (b) is correct.

3. $T_s = \frac{4}{\zeta \omega_n} \leq 8$ $\qquad e_{ss} = \frac{p}{K} \leq \frac{1}{10}$

$\frac{1}{2} \leq \zeta \omega_n$ $\qquad 10p \leq K$

$\frac{1}{2} \leq \frac{p}{2}$ $\qquad 10 \cdot 2 \not\leq 16$

$1 \leq p$ ⟵ $p = 2$ satisfies this

$K = 16,\ p = 2$ does not satisfy s.s. error criteria.

4. Please see next page.

5. $Y(s) = \underbrace{\frac{G(s)}{1 + KG(s)}}_{\frac{N(s)}{D(s) + KN(s)} = \frac{1}{s^2 + ps + K}} \cdot D(s) + \frac{KG(s)}{1 + KG(s)} \cdot R(s)$

$$y_{ss} = \lim_{s \to 0} \cancel{s} \frac{1}{s^2 + ps + K} \cdot \frac{1}{\cancel{s}} = \frac{1}{K}$$

$\therefore$ (a) is correct.

4. This plot shows steady-state error, <u>not</u> marginal stability. We know the system is asymptotically stable. It should converge to 0 if there is perfect tracking, but because this system is type 1, perfect tracking is not possible.